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University of Maine

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 193 November, 1911

POULTRY NOTES

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BULLETIN No. 193.

POULTRY NOTES—1910.

Raymond Pearl.

The purpose of this bulletin is to present a brief report of the progress of the work of the Station with poultry during the year 1910. The publication of such summary reports annually is a definite policy of the Station. It is the object of these reports not only to give an account of the work done, but also to present a more or less complete account of various points regarding poultry management, which arise incidently in connection with the main lines of investigation which are being followed with poultry. These main lines of investigation are poultry breeding, particularly for increased egg production, and the physiology of egg production. No topics will be discussed in this bulletin which have been, or are to be treated in other bulletins of the Station.

A Fresh Air Brooder.

For a number of years prior to 1910 the Maine Station used in rearing chickens a commercial, hot air, brooder known by the trade name "Peep-o'-Day." These brooders never gave entire satisfaction. During the period in which they were used the mortality during the first three weeks in the brooder was too large, and remained so even after all factors other than the brooder had so far as possible been corrected.

After careful consideration of the matter it appeared that there were three fundamental defects in brooders of the "Peep-o'-Day" type. These are: (1) in order to get a sufficiently high temperature underneath the hover in the sort of weather which prevails in this locality during the latter part of March and first part of April it is necessary to turn the lamp so high that the floor of the brooder gets much too hot. In other words, if brooders of this type are forced at all there is too much "bottom heat." (2) Brooders of this kind have no provision for taking the lamp fumes and vitiated air out of the building in which the brooder is operated. This becomes a very serious matter when, as is the case at this Station, two of these brooders are operated in a small colony house, with a floor area of only 6 or 7 feet by 12 feet. In the cold weather of April it is necessary to shut these houses at night in order to maintain anything like the proper temperature underneath the hovers. When the door of such a house with two Peep-o'-Day brooders operating in it is opened in the morning the air is plainly very bad. Not only does it contain all the lamp fumes, but it also has a peculiarly dry, burned-out smell. (3) When these brooders are operated in small colony houses, and the same houses are used for growing the chickens on the range throughout the summer, a considerable labor expense and a good deal

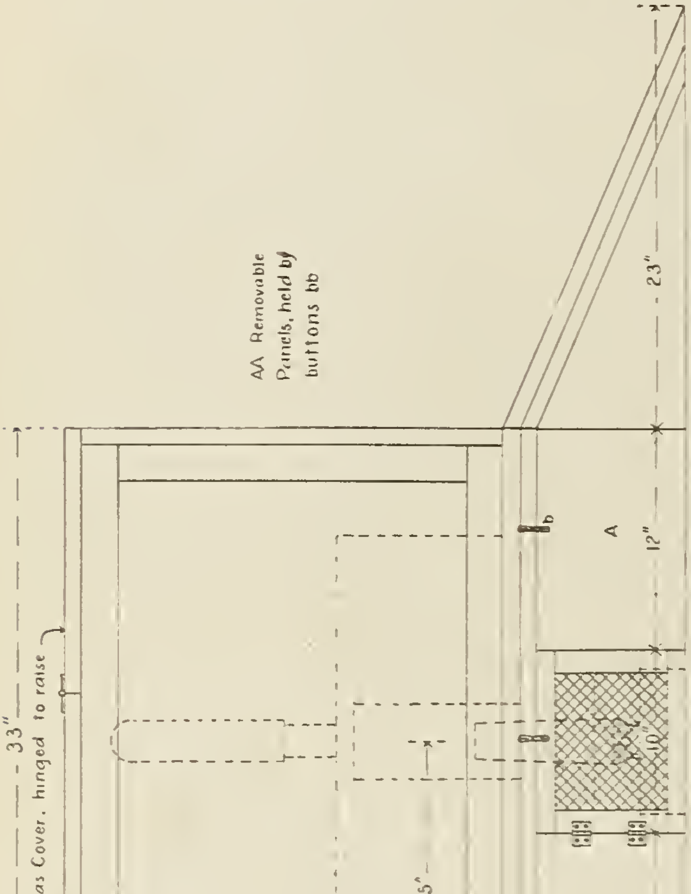
AA Removable Panels, held by buttons bb
Canvas Cover, hinged to raise
33"
23"
12"
10"
10"
15"
A
A
b
b

FIG. 85. End elevation of brooder. Note sloping run to floor, hinged cover, removable side panel AA on base of brooder. In the center of this is a small door made of 1/4 in. mesh galvanized wire. Through this door the lamp is withdrawn for filling and cleaning. The panel AA is removed from the brooder is dismantled, and the whole superstructure is then packed away under the base. See text for further explanation.

of wear and tear on the brooders themselves is involved in moving them about. After the chicks have reached a size when it is no longer necessary for them to have a hover the brooders must be moved out and stored somewhere until the houses are cleaned out in the fall. Then the brooders have to be moved back in again in preparation for the next year's hatching season. All this involves a good deal of labor. Every poultryman knows, or ought to know, that one of the primary factors in determining financial success or failure in the poultry business is the labor cost. Any plan which attains a real saving of labor, without involving any disadvantages in other ways, is to be welcomed. Certainly the operation of brooders which have to be handled about so much every season constitutes a labor leak, which on a large plant operating 50 to 100 brooders is considerable in amount. Of course it will be understood that this criticism does not apply to Peep-o'-Day brooders alone but to all indoor brooders on the market known to the writer.

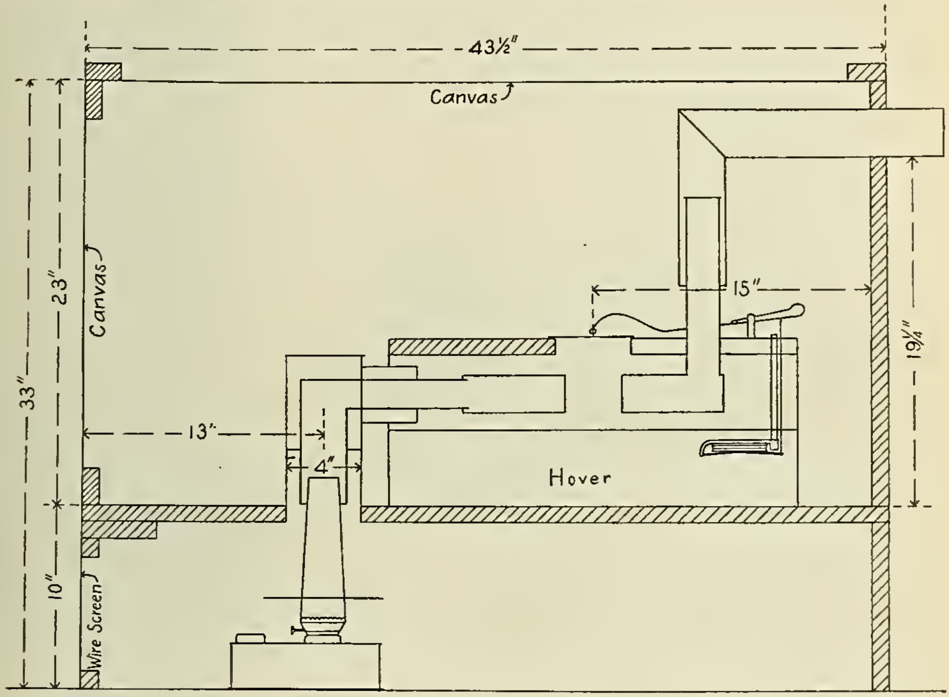

FIG. 86. Section through middle of brooder. Note cloth cover and side, large space between floor of brooder and floor of house, in which the lamp is placed while the brooder is in operation, and which serves as a storage place for the whole upper part of the brooder when the latter is not in use.

In view of these considerations it was decided in the hatching season of 1909 to begin some experiments looking toward an improvement in the brooders used for rearing the chickens at this Station. At first some different types of commercial brooders were tested. The results, however, were not satisfactory. Before the hatching season of 1910 it was decided to try on an experimental scale a brooder devised to overcome the objections mentioned above to brooders of the Peep-o'-Day type. Accordingly 6 brooders were constructed embodying the essential features of that to be described below, and were put in use during the hatching season of 1910. Dur-

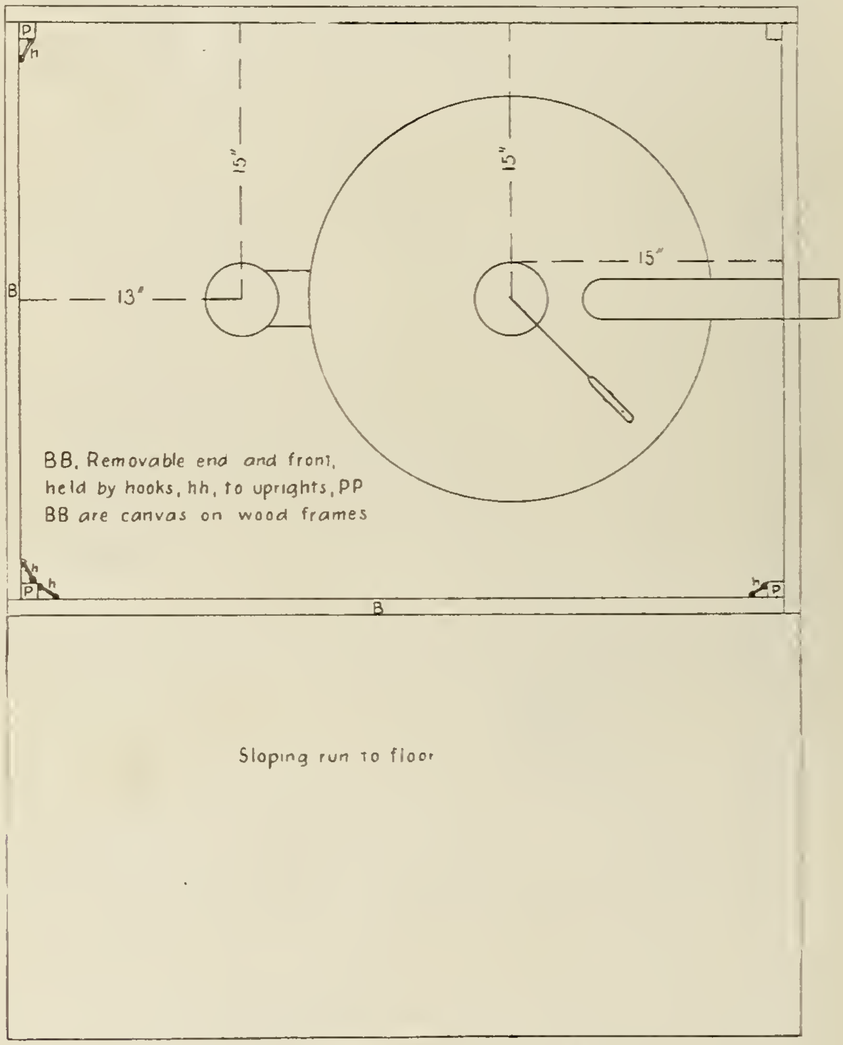
P
h
15"
15"
15"
B
13"
BB. Removable end and front, held by hooks, hh, to uprights, PP
BB are canvas on wood frames
h
P
h
h
P
B
Sloping run to floor

FIG. 87. Floor plan of brooder. For further explanation see text.

ing that year it was possible to compare the work of these 6 brooders with the Peep-o'-Days under the same conditions and with uniform lots of chicks. The results obtained were strikingly favorable to the new brooders. At the same time this practical test brought out clearly a number of minor points in which the new brooder could be improved. In the fall of 1910 all of the Peep-o'-Day brooders which had been used by the Station were discarded and a complete equipment of the brooder to be described was installed. It is proposed in this bulletin to give a detailed description of this brooder, together with working plans so that any poultryman can construct one for his own use if he cares to do so.

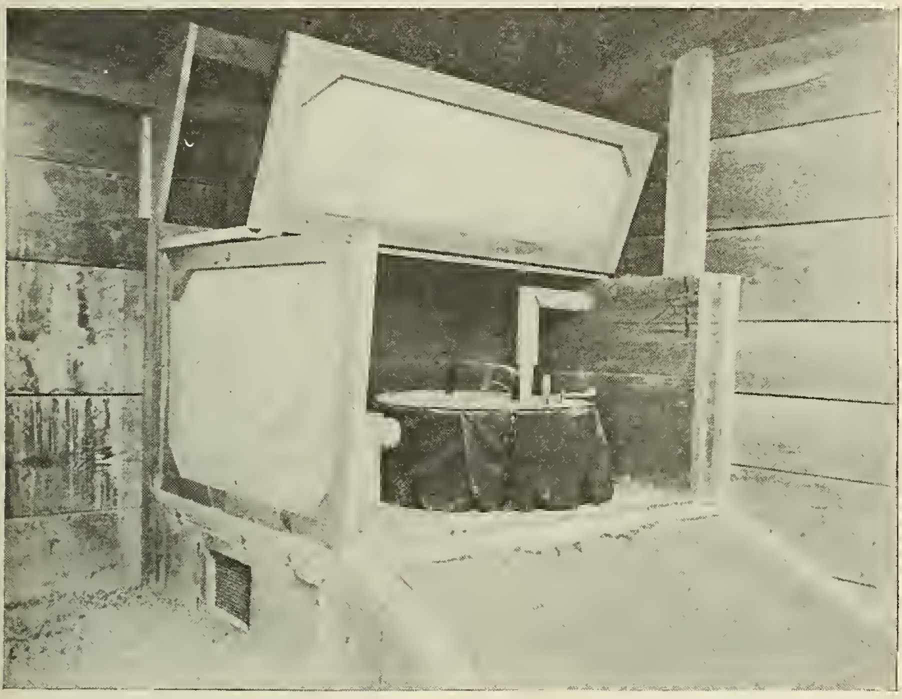

FIG. 88. Showing brooder installed and ready for operation.

The advantages which have been found to accrue from the use of this brooder at the Maine Station fall into two general categories. The first of these is that it is possible to rear in this brooder a larger number of chickens in proportion to the number originally put in than in any other brooder with which the Station has had any experience. That is, the mortality rate of chicks raised in this brooder, is relatively low, particularly as compared with brooders of the Peep-o'-Day type. Furthermore not only do the chicks live better in this new brooder but also, according to our experience, those which do live grow better and are thriftier than those raised in the other type of brooder. The second advantage lies in the great saving of labor which is effected by the use of the new brooder. The fact that the brooder never has to be removed from the house where it is operated means a decided economy.

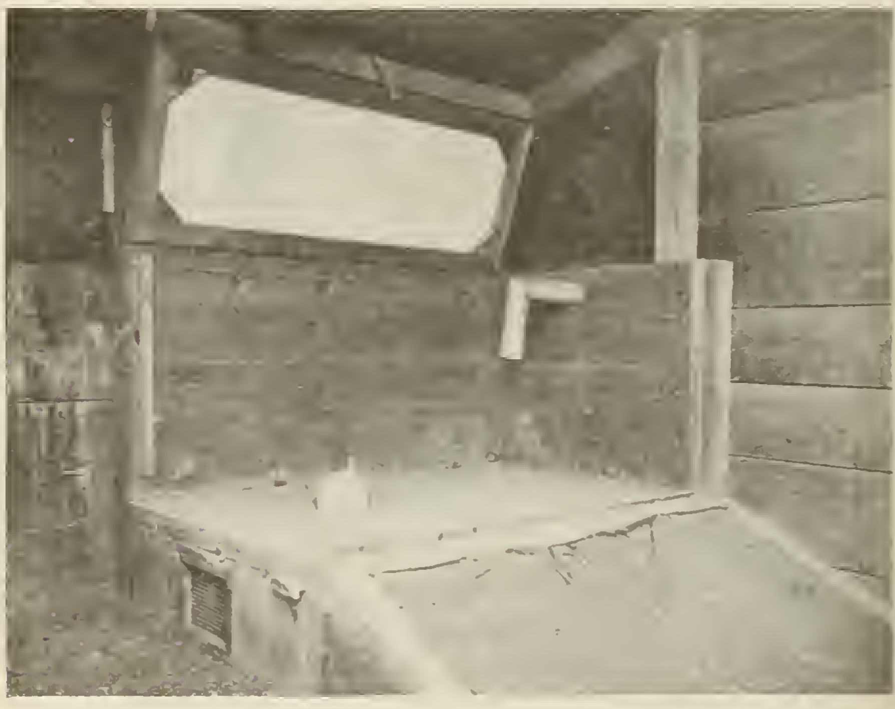

FIG. 89. Showing brooder dismantled and parts stored in base.

CONSTRUCTION OF BROODER.

In planning this brooder the primary point aimed at was to make it a "fresh air" and a "pure air" brooder. With this idea in mind it was thought advisable to make the wall of the brooder in some degree permeable to air. To meet this requirement the walls and cover of the brooder are made of cloth. Essentially the brooder is a cloth box containing a hover, of the type in which the lamp fumes are conducted outside of the building by an exhaust pipe.

These brooders are built permanently into the houses which they occupy. Two brooders are placed in each colony house.

one in each of the back corners of the building. In this way one end wall and the back wall of the building form two of the sides of each brooder. The remaining side and cover are made of cloth tacked on light wooden frames as shown in the working drawings.

The floor of the brooder stands 10 inches above the floor of the house. From the front of the brooder a sloping walk extends down to the house floor, reaching in width clear across the whole front of the brooder. The cloth front and side of the brooder are not permanently fixed in position but are removable panels, which are held together and to the frame work by hooks and eyes (see fig. 87). The cover is hinged in the middle in such a way that it can be either half opened or entirely opened and folded back out of the way. In consequence of this arrangement it is possible to regulate with great nicety the amount of air which shall be admitted to the brooder. Either the front or the side panel may be tilted out as much as desired at the base thus admitting air there. Furthermore by partly opening a panel and the cover it is possible to insure that there shall be a circulation of air through the brooder at all times.

The hover used in this brooder is the Prairie State Universal Hover made by the Prairie State Incubator Company, Homer City, Pennsylvania. It is, however, modified in certain particulars for present use. In the first place the arrangement is such that the lamp is inside the house underneath the brooder rather than in a box outside the house, as in the usual arrangement of the Universal hover. The lamp in this brooder is in the house directly under the brooder just as in the case of the Peep-o'-Day. The reason for this modification is that in this climate, where one is likely to have bad weather during the early part of the hatching and rearing season, with heavy winds, snow, and rain, it is much easier and more satisfactory to take care of the lamp inside the house than from a small box outside the house. Another modification is that in the hovers which are installed in these brooders an especially heavy insulation is put on top of the drum to reduce the loss of heat by radiation in extremely cold weather early in the spring.

One of the essential points about the brooder is its compactness in storage, and the fact that all the parts may be stored in the base of the brooder itself. In this way the labor expense of carrying back and forth parts from a storage house each year is avoided. To bring about this result the size of the base is so calculated that all the parts of the brooder may be enclosed in it. The way in which this is done is apparent from an examination of fig. 85. It will be seen that the end of the brooder base, (marked *AA* in the diagram) is removable, being held in place by buttons *bb*. When the end of the brooding season is reached and there is no further use for the brooder that year, the side and front end panel of the brooder are removed, the canvas cover folded back and tacked to the wall of the building and the hover dismantled. All of the parts are then shoved under the brooder floor and the panel *AA* put back in place again. The floor of the brooder is removable so that it, and the floor underneath, may be cleaned and disinfected. By removing the legs the hover may be stored in the brooder base along with the other parts, or if one does not desire to do this the hover may be suspended close up to the roof of the building. In that position it will be impossible for the birds to roost on it. Of course, all removable parts should be taken from the hover before it is hung up in this way. These parts may be stored in the brooder base. After the chickens are out of the house in the fall the parts of the brooder are taken out, thoroughly cleaned and disinfected, and then the whole is reassembled and made ready for the hatching season of the next year.

Detailed working drawings of the brooder are given herewith. Fig. 85 shows the end elevation of the brooder; fig. 86 shows a section through the middle of the brooder; fig. 87 shows a floor plan; fig. 88 shows the brooder in operation; and fig. 89 shows its appearance when dismantled and with the parts stored in the base, while the large chickens are using the house. All dimensions are given on these drawings and from them it should be possible for anyone to construct the brooder for himself.

As material any sort of planed lumber may be used. Probably pine will be found satisfactory and economical in most cases. Spruce or hemlock may be used to build the base, if one desires. For the cover and removable sides almost any sort of cloth may be used. Here we have employed the lightest weight canvas (duck) that could be obtained locally. Burlap may be used, or even unbleached cotton cloth in localities where the outside temperature is not too low.

THE ABANDONMENT OF THE ROOSTING CLOSET.

In the curtain front type of house used at this Station a feature of the original plan on which considerable stress was laid was the canvas curtain in front of the roosts.* This curtain, together with the back wall of the house and the droppings board under the roosts formed a closet in which the birds were shut up at night during cold weather. When the curtain-front house was first devised it was thought essential to provide such a closet to conserve the body heat of the birds during the cold nights when the temperature might go well below zero. Experience has shown, however, that this was a mistake. Actual test shows that the roosting closet is of no advantage, even in such a severe climate as that of Orono. On the contrary the birds certainly thrive better without the roost curtain than with it. It has been a general observation among users of the curtain front type of house that when the roost curtains are used the birds are particularly susceptible to colds. It is not hard to understand why this should be so. The air in a roosting closet when it is opened in the morning is plainly bad. The fact that it is warm in no way offsets physiologically the evils of its lack of oxygen and excess of carbon dioxide, ammoniacal vapors and other exhalations from the bodies of the birds.

For some time past it has been felt that the roosting closet was at least unnecessary, if not in fact a positive evil. Consequently the time of beginning to close the roost curtain in the fall has been each year longer delayed. Finally in the fall of 1910 it was decided not to use these curtains at all during the winter. Consequently they were taken out of the house, or spiked to the roof as the case might be. The winter of 1910-11 was a severe one. On several occasions the temperature dropped to 30 degrees below zero. Yet during this winter the mortality was exceptionally low and the egg production exceptionally high. The roost curtain will not again be used at this Station.

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* See Farmers Bulletin 357.

ON THE ACCURACY OF TRAP NEST RECORDS.*

All experimental studies of any magnitude on fecundity in the domestic fowl must rest ultimately upon trap nest records. In spite of the fact that so much trap nesting work has been done in the various Experiment Stations there has never been any careful study, so far as the writer is aware, of what may be called the *residual error* of trap nest records. By "residual error" is meant that error which remains after all instrumental sources of error, such as, for example, failure of a nest to operate owing to its being out of repair, have been eliminated. It will always be the case that some birds will at some times lay outside the trap nest. The important point to anyone concerned in the accuracy of the records relates to the amount of this error. It is proposed here to present some data collected at the Station regarding this matter. Prior to the fall of 1908, what was known as the Maine Station type of trap nest * was in use over the whole plant. A very slight study of the matter convinced one that the instrumental error involved in the use of this nest was too large, both absolutely and relatively. This resulted from several factors but the following defects were most serious. (1) The hens would lay in the front compartment of the nest and not get trapped. (2) The door would fail to lock when the nest was sprung, and thus while the hen inside could not get out, another one (or more) could get inside. (3) In general the nests very easily got out of repair, and then failed to work properly. While in theory it ought to be easy to repair immediately all such nests, in practice it was impossible to prevent there being constantly on the plant a few nests not working properly and needing repairs.

It was believed that with a more efficient trap nest the number of unrecorded eggs could be reduced. Accordingly a new trap nest was devised. This has been described elsewhere.* These nests were installed in the fall of 1908, so that the pullets put into the house that year had nests of the new pattern. Since the writer took charge of the work an accurate, permanent record has been kept of all eggs laid elsewhere than in a trap nest (i. e. in such way as to make it possible to know the hen which laid the egg). Because records of this kind were not preserved prior to the month of January, 1908, the only period for which figures are available regarding the accuracy of the old type of nest as compared with the new is from January to June, 1908.

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* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 30.

* For original description see Me. Agr. Expt. Stat. Ann. Rept. for 1898, pp. 141-143.

* U. S. Dept. Agr. Farmer's Bulletin 357, pp. 36-39, 1909.

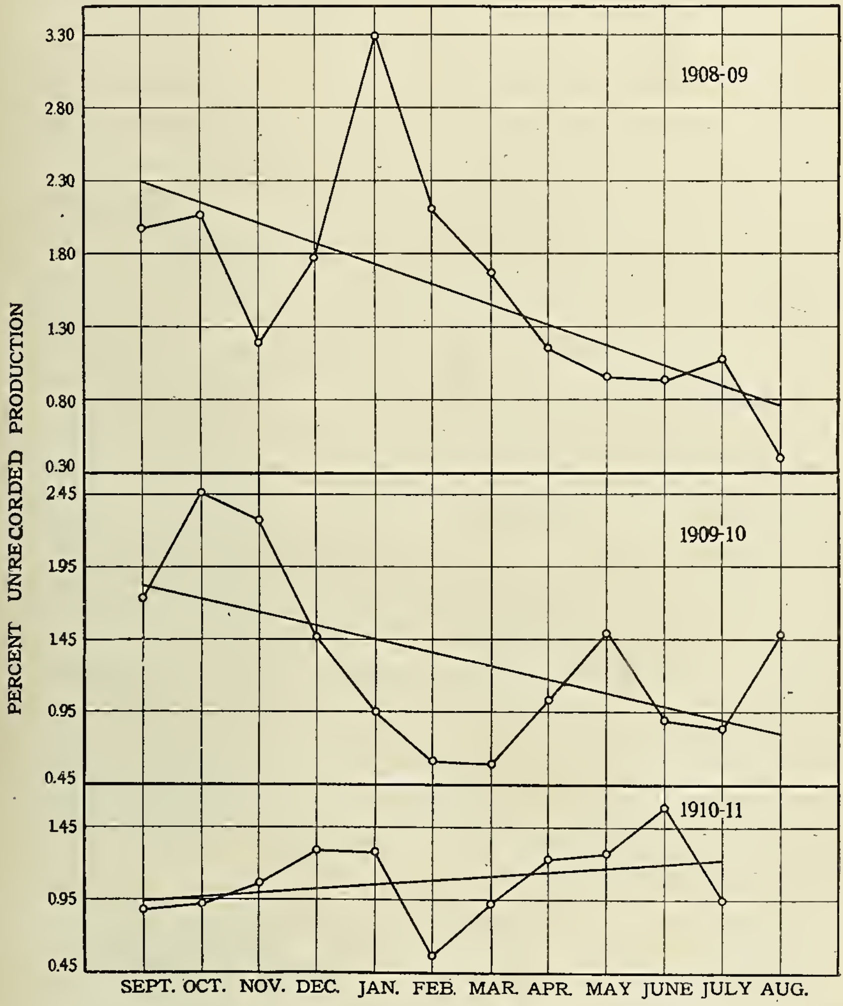

FIG. 90. Diagrams showing the trend of the relative (percentage) amount of unrecorded eggs during the successive months of the laying year, for the laying years, 1908-09, 1909-10, 1910-11.

The following table gives the data from January, 1908, to the present (August, 1911,) regarding the accuracy of the trapnests in use on the Station plant. The figures given include *all* eggs laid on the plant regardless of what experiments the birds were in. The number of birds on the plant varied from time to time, so that the totals in this table are not to be used as an index of the laying of the stock. For example it will be noted that whereas in July, 1909, 6106 eggs were obtained, in the following month there were only 504. This might be taken to indicate a tremendous drop in the rate of fecundity of the birds, but actually it merely means that on August 1, 1909, the houses were cleaned out and all the laying birds were sold except a small number kept over for breeding purposes. In this table the column headed "Nest Eggs" gives the number of eggs laid in the trap nests in such way that the bird which laid each of these eggs was known. The column headed "Unrecorded Eggs" gives the number of eggs laid on the floor of the pen or in some other situation such that it was not possible to know the individual hen which laid each egg.

In order that the data set forth in this table may be more readily comprehended fig. 90 has been prepared. In this diagram the trend of the percentage figures during the last three years is shown. The zigzag line in each case represents the observations. The straight lines are fitted to these observation lines by the method of least squares. The equations to these lines are as follows, y denoting "percentage of unrecorded eggs the nest eggs," and x denoting months, the origin of x being taken as one month before the first observation of the laying year, viz. that for September:

1908-09 .... $y=2.44-.14\ x$
1909-10 .... $y=1.93-.094x$
1910-11 .... $y=0.92+.029x$

This table and the diagrams show that:

(1) The residual error was more than three times as great with the old type of trap nest as it is with the new. Taking the three laying years, 1908-09, 1909-10, and 1910-11, together the grand totals are: 151,355 nest eggs and 1881 unrecorded

TABLE I

Showing the Residual Error of Trap Nest Operations from January, 1908, to July, 1911

MONTH.	1907–1908.			1908–1909.			1909–1910.			1910–1911.		
	Nest eggs.	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs.	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs.	Unrecorded eggs.	Per cent unrecorded eggs to nest.
September	–	–	–	742	15	1.98	677	12	1.74	1685	15	0.88
October	–	–	–	945	20	2.07	1217	3	2.46	2796	26	0.92
November	–	–	–	1067	13	1.20	1243	29	2.27	2771	30	1.07
December	–	–	–	2587	46	1.78	3622	54	1.47	3146	41	1.29
January	5172	189	3.52	4896	167	3.30	4471	43	0.95	3854	50	1.27
February	6946	277	3.83	5145	111	2.11	3601	22	0.61	5713	33	0.57
March	13111	561	4.10	7938	136	1.68	5921	35	0.59	9408	88	0.93
April	12474	510	3.92	7721	91	1.16	6130	64	1.03	8898	109	1.22
May	11757	504	4.11	7155	69	0.96	4883	74	1.49	8136	104	1.27
June	8914	395	4.24	6200	59	0.94	4009	36	0.89	6424	102	1.59
July	–	–	–	6040	66	1.08	4061	34	0.83	6221	59	0.95
August	–	–	–	502	2	0.40	1530	23	1.48	–	–	–
Totals and means	58374	2436	4.01	50938	795	1.53	41365	429	1.03	59052	657	1.11

eggs; giving a percentage of 1.24 unrecorded eggs. We then have for the ratio of efficiency of old nest to new:

$$\frac{\text{Old trap nest}}{\text{New trap nest}} = \frac{4.01}{1.24} = 3.23$$

(2) The relative amount of unrecorded egg production is not closely related to the total egg production. This is indicated by the fact that the curves of unrecorded eggs by months do not at all parallel the familiar curve of the seasonal or monthly distribution of egg production.* The absolute number of unrecorded eggs tends to increase as the nest eggs increase, and diminish as the latter diminishes. But there is no indication whatever in the figures that *proportionately* more eggs are unrecorded when the laying is heavy than when it is light, and *vice-versa*.

(3) There is plainly in the years 1908-09. and 1909-10 a tendency for the unrecorded production to diminish relatively as time elapses from the beginning of the laying year. That is to say, the longer the same individual birds use the trap nests, the smaller becomes the production of unrecorded eggs. This suggests what is actually the fact. that there is an element of learning in the operation of trap nests, looked at from the standpoint of the bird. In a lot of several hundred pullets put into the *laying* house in the fall there will always be a few who have to be *taught* to use trapnests, or for that matter. any kind of a nest. Usually such birds learn fairly rapidly to lay in nests. There are occasional lapses. but the number of these tends to become smaller the longer the bird has used a nest. It is on this account that the relative proportion of unrecorded eggs tends to diminish during the course of the laying year.

(4) The year 1910-11 seems to furnish a contradiction to the statements made in (3). In that year the proportionate number of unrecorded eggs was actually greater towards the end of the laying year than at the beginning, though the amount of the change was so small as not to be significant. Practically the line is horizontal. It is not possible to state posi-

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*Cf. Pearl and Surface, U. S. Dept. Agr. Bur. An. Ind. Bul. 110. Part II, p. 90.

tively all the factors which are concerned in the failure of the unrecorded eggs to diminish during the year 1910-11.

Direct observation indicates, however, that the chief cause of the relatively high amount of unrecorded production towards the end of this year (April, May and June) is to be found in the behavior of certain cross-bred birds with respect to broodiness. A number of these birds would show all the symptoms of a severe attack of broodiness, yet after being put into the broody coops to be "broken up" would continue to lay regularly on the floor of the coop. This happened so many times as to leave no doubt as to the fact, nor as to the relatively frequent occurrence of this type of behavior among the cross-bred birds. Owing to its unexpectedness we were not prepared this year to keep any exact records respecting the phenomenon. To do this involves penning each broody bird alone. Next year it is proposed to do this, and thus get precise records on a matter regarding which we have so far only general observations. From the evidence now in hand it seems probable that what we have here is an effect of the separate Mendelian segregation of "broodiness" and "fecundity." In the care of these F_2 birds of the peculiar behavior described we apparently have individuals carrying *both* "high fecundity" and "high broodiness" genes. The resulting behavior is a sort of compromise between the two tendencies. It might be thought that such a result would be a physiological impossibility. This is not so. Paradoxical the result certainly is, but plainly not impossible, since it is actually the case that these birds have every physiological attribute of broodiness, and yet lay regularly. In this connection it should further be said that a study of a large mass of unpublished quantitative data on broodiness shows that the physiological correlation between the function of laying and that of brooding, is by no means perfect. Perfect "broodiness" may be developed before any egg laying has occurred. Further as in the present cases, broodiness and egg laying may coexist over long periods. The writer hopes to be able shortly to publish in full the data on the physiology and inheritance of broodiness which have accumulated during the past four years.

DISCUSSION.

From the figures given above it appears that, on the average, during the past three years, there has been for every 100 eggs laid on the Station plant only one and a quarter eggs which it was not possible to credit to the individual bird. This probably represents something approaching the irreducible minimum of error in trapnesting work on any large scale. The reason that it is believed to be substantially irreducible is that further to increase the proportion of recorded eggs would involve the intelligent coöperation of the hen, a factor not easily controlled. In this 1 1-4 percent of unrecorded eggs only a very small fraction (less than one percent) is chargeable to instrumental errors. It is probably safe to say that no trapnest (or other piece of machinery) can ever be devised which will effectively meet all situations which will arise. In a very few instances, amounting as has been said to less than one percent of the *unrecorded* (not the total) egg production, two hens will go precisely together into the trapnest, or one will sit on the door while another walks in, lays, and walks out again. The new Maine Station nest has, however, reduced the instrumental error practically to nothing.

With no instrumental error, however, there remains some unrecorded egg production. This arises in the main from the following factors:

1. *Laying on the floor of the house.* This may be due to
    - (a) Instinct to "steal a nest." This can be cured if taken in hand early.
    - (b) Purely physiological inability to hold up the egg longer. This may happen when all the trap nests are full and a hen wanting to lay cannot get in, or it may happen when an attendant throws out of the nest a bird which has been on the nest for some time, has not yet laid, but is just on the point of doing so. These are purely accidental matters and cannot be entirely controlled though with care they may be largely so.
    - (c) Lack of familiarity with nests. Common in young pullets, which have to be "taught" by direct methods to use nests.
2. *Laying in "broody coops."* This has already been discussed.

3. *Dropping eggs while on roosts.* Eggs are sometimes found on the roost boards in the morning. They indicate a disturbance of the normal laying rhythm.

From this enumeration it is plain that full control of the matter demands intelligence and coöperation on the part of the hen.

It should, of course, be understood that the sources of error here discussed are not the only ones in trapnesting. They are merely the ones which are *peculiar* to that work. It is always possible to misread a leg band or to set down an incorrect number on the record sheet. Here the skill and experience of the recorder are the important factors. It is believed as a result of studying a great many records, and applying many different sorts of checks that in this respect as well as in the other the Maine Experiment Station trap nest records during the last three years, as made by Mr. Walter Anderson, have attained a minimum of error, which, considering the scale of operations, is humanly not substantially reducible.

Technical Studies On Poultry Already Published.

A considerable portion of the more technical scientific work of the department of biology of the Station, which has in charge the work with poultry, is published in current biological journals, not readily accessible to the agricultural public. It is the purpose of the present section of this bulletin to give briefly the essential points brought out in certain of these technical studies which have been published during the past year.

THE SEASONAL DISTRIBUTION OF EGG PRODUCTION.

During the year Part II of the "Biometrical Study of Egg Production in the Domestic Fowl" * has been issued. This part deals with the distribution of egg production during the different parts of the laying year. Summarized the results of this study are as follows:

The data on which this study is based are the trap nest records of Barred Plymouth Rocks collected at the Maine Experiment Station, involving detailed monthly egg records of more than 2,400 birds, collected in a period of nine consecutive years.

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*U. S. Dept. Agr. Bur. An. Ind. Bulletin 110, Part II, pp. 81-170. 1911.

The chief results of this analysis are summarily stated in the following paragraphs:

1. The mean or average monthly egg production exhibits the following characteristic changes in the course of the laying year:

(a) The lowest mean production of the year is in the month of November.

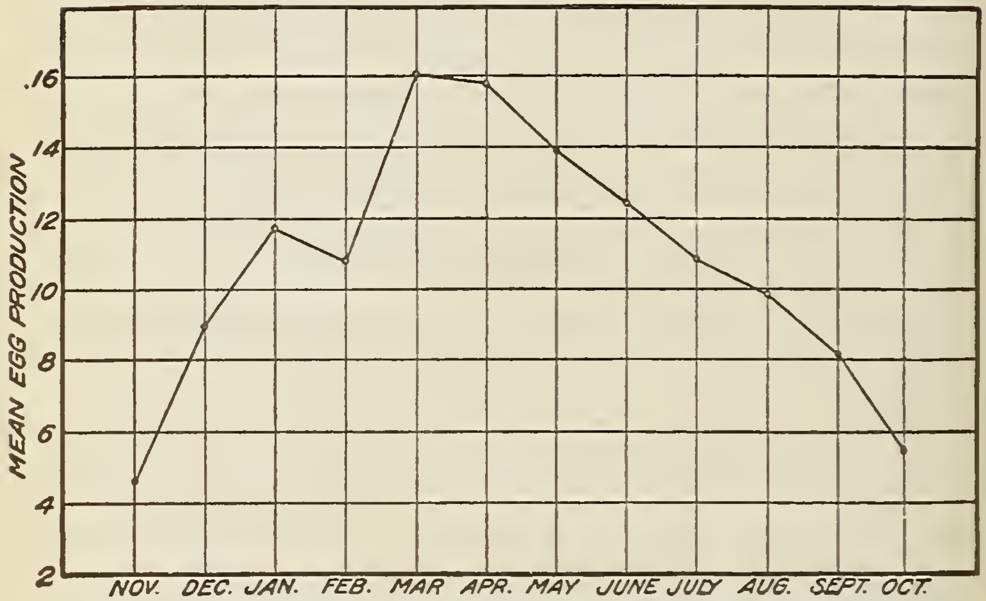

FIG. 91. Diagram showing the weighted mean monthly egg production for each month of the pullet year.

(b) The mean monthly production increases in December and January at a relatively very rapid rate.

(c) There is a slacking up in the rate of increase in February, which probably represents the point of the ending of the first, or winter, cycle of egg production. This February slacking up amounts in many cases to an actual decrease in productiveness as compared with the point attained in January.

(d) The mean production reaches a maximum in March.

(e) While the mean production for April is practically the same as that for March, there is a steady decline after April on to the end of the laying year in October.

(f) There is a tendency toward a slightly larger drop in mean production in May. This is the period of natural broodiness.

2. The present data indicate that only a trifle more than a quarter of the total eggs produced are laid in the winter third of the year (November 1 to March 1). In the first two-thirds of the laying year approximately three-fourths of the total eggs are produced.

Diagrams showing the nature of the seasonal distribution of egg-production are presented in figs. 91 and 92.

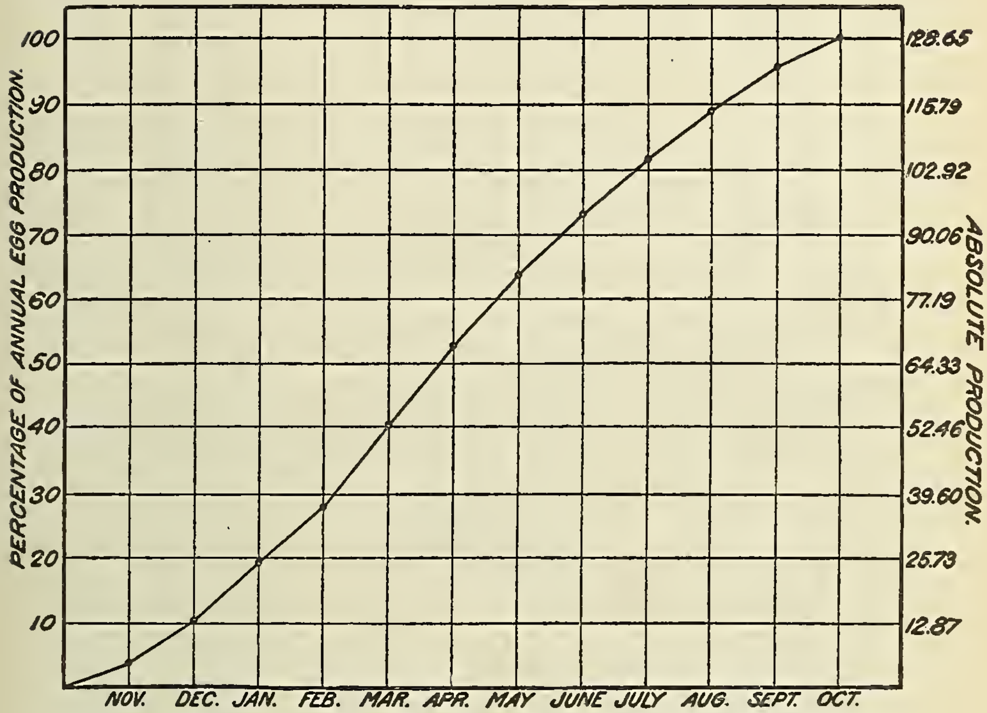

FIG. 92. Integral curve of weighted mean monthly egg production, showing the absolute and relative number of eggs laid from the beginning of the laying year up to the end of each month.

3. The month of maximum productivity varied in the experiments furnishing the present data with the methods of housing. In a closed, warmed house the month of maximum production was April; in a curtain-front house it was March.

4. The greatest relative variability in egg production is at the beginning of the laying year (month of November). The month of lowest variability, both absolute and relative, is April.

5. The laying year may be divided into four natural periods or cycles with reference to egg production. The first of these periods (roughly November 1 to March 1) is the winter period, wherein egg production is essentially a non-natural (i. e., forced

or stimulated) process. The second or spring period (March 1 to June 1) is the natural laying period of the domestic fowl in its normal reproductive cycle. The third (roughly June 1 to September 1) and fourth (roughly September 1 to October 31) periods are not sharply separated from one another. The summer egg production represents in part a natural continuance of the normal breeding season (rearing of a second brood by wild *Gallus*) and in part a stimulated process. This period is terminated by the molt, which is the characteristic feature of the fourth period.

6. There is no evidence that the continued selection for higher egg production practiced during the eight years covered by the experiment produced any increase whatever in the mean egg production of any month in the year. On the contrary, the mean production in all but two of the months actually decreased during the period of selection.

7. So far as there was any change whatever in variability in monthly egg production during the period when selective breeding was practiced, this change was not in the direction of a reduction as a result of the selection, but, on the contrary, there was an actual increase in variability in all but one month of the year, and here the platted variability line did not sensibly deviate from the horizontal.

8. The present statistics show no bad effect on egg production in the winter months (November to March) of keeping birds in large and crowded flocks (up to the limits included in the present study). On the other hand, overcrowding tends distinctly to lower summer (and to a smaller extent spring) egg production. It is chiefly as a result of this effect on summer production that the mean annual production is lower in the large flocks, as shown in Part I of this work (Bureau of Animal Industry Bulletin 110, Part I, pp. 58-61).

9. The excess in relative variability of egg production of the larger flocks (100 and 150 birds) over the smaller (50 and 100 birds) observed in the annual records (see Part I) is found upon analysis to be on the whole fairly evenly distributed over the whole year. In the period of the year in which there is the heaviest production, such environmental differences as are implied in the different flock sizes in the experiment do not appreciably affect the relative variability of production.

10. The polygons of variation in monthly egg production are all bimodal, though homogeneous. The position of the mode changes in a regular manner during the course of the laying year, as does also the skewness of this portion of the distributions. These monthly distributions may be described as S-shaped, and are in general of the same type in the different months, though different in detail.

11. By a process of mathematical reasoning set forth in detail in the original paper it is shown that the observed facts regarding the character of the distributions of variation in monthly egg production are adequately accounted for by an hypothesis which includes the following points. These statements are therefore set down as conclusions of this study:

(a) That variation or changes in the rate of fecundity in the hen are fundamentally or innately continuous (in the mathematical sense), though the objective manifestation of fecundity is discontinuous, i. e., expressed in discrete units.

(b) That visible egg production in each individual bird tends to occur in definite cycles or periods of varying length which alternate with nonproductive periods.

(c) That the rate of fecundity (amount of egg production per unit of time, conceived in the sense of the differential calculus) is in any bird at a minimum at the beginning of a cycle of production, increases to a maximum at what may be termed the height of the cycle, and decreases to a minimum (usually quite rapidly) as the end of the cycle is approached.

(d) That each of the monthly fecundity distributions is compound, and made up of two parts. In one part are included all birds which are well along in a period of laying activity (or cycle of fecundity). The other part includes those birds not laying at all (that is, in a non-productive condition or period) and those that have just emerged from this condition of zero fecundity and started on a laying cycle.

(e) That (1) the proportion of the whole flock which falls into each of these two classes, and (2) the particular rate of fecundity which marks the boundary between the two classes, are not constant, but, on the contrary, change in a definite and orderly manner in the different parts of the laying year.

(f) That the distribution of frequency within each of the two hypothetical components of the monthly fecundity distributions follows a simple, unimodal skew frequency curve, and that the curve describing the entire monthly fecundity distribution is in each case the sum of two skew frequency curves.

DOES "PROTECTIVE COLORATION" IN POULTRY REALLY PROTECT?

It is an obvious and easily demonstrated physical fact that fowls with a barred or broken color pattern are relatively inconspicuous as compared with birds with either solid black or white plumage, or so dark in general color that any pattern which may be present is not visible except on close examination. Does the inconspicuousness of barred birds protect them against their natural enemies, such as crows, hawks, foxes, rats, etc.?

Some two years ago C. B. Davenport published a short note regarding the relative number of self-colored and of "pencilled or striped" chicks killed by crows one afternoon, at Cold Spring Harbor. The rather striking result was that out of 24 birds killed, only one was other than self-colored. The communication closes with the following words: "This fragment, then, so far as it goes, indicates that the self-colors of poultry, which have arisen under domestication, tend to be eliminated by the natural enemies of these birds, and the pencilled birds are relatively immune from attack because relatively inconspicuous."

Records kept at this Station in connection with the breeding work throw light on this matter. A discussion of these records has recently been published.* The results may be summarily stated as follows:

We have the following figures, it being understood that "eliminated" means "killed by natural enemies" with the inclusion of the small number of birds which lost their bands. (See original for details).

Total number of birds on range =3.343
Number of *barred* birds =3.007
Number of *solid-colored* birds = 336
Total number of eliminated birds = 325
Number of *barred* birds eliminated = 290
Number of *solid-colored* birds eliminated = 35

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* Data on the Relative Inconspicuousness of Barred and Self-colored Fowls. American Naturalist, Vol. XLV, pp. 167-177. 1911.

The above figures include *all* eliminated birds, those killed by recorded and unrecorded enemies together. If we take only those killed by recorded enemies, which under the conditions prevailing on the plant in 1909 means practically those killed by rats, we have:

Number of *solid-colored* birds eliminated by recorded enemies =6.

Number of barred birds eliminated by recorded enemies =68.

From these figures the following proportions are derived: Of the *total number* of birds 10.05 per cent. were *solid-colored.*

Of all the *eliminated* birds 10.77 per cent. were *solid-colored.*

If we consider by themselves the birds eliminated by recorded enemies, we have:

Of the birds *eliminated by recorded enemies* 8.11 per cent. were solid-colored.

Putting the figures in another way we have:

Of the *solid-colored* birds 10.42 per cent. were eliminated by *all* enemies.

Of the *barred* birds 9.64 per cent. were eliminated by *all* enemies.

Of the *solid-colored* birds 1.79 per cent. were eliminated by *recorded* enemies (chiefly rats).

Of the *barred* birds 2.26 per cent. were eliminated by *recorded* enemies.

Of the *solid-colored* birds 8.63 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

Of the *barred* birds 7.38 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

The conclusion to be drawn from these figures, which involve a large number of individuals, is obvious. It is that *the relative inconspicuousness of the barred color pattern afforded its possessors no great or striking protection against elimination by natural enemies, during the season (April 1 to October 1) of 1909 on the poultry range of the Maine Experiment Station.* It might be objected that if the eliminations by predaceous birds alone could be separately recorded it would then be found that against this class of enemies the barred pattern had great protective value, as suggested by Davenport's figures. This, however, can hardly be the case in the present statistics since if it be assumed that predaceous birds killed relatively few barred chicks and relatively many solid-colored, then it must also be assumed that the other unrecorded enemies showed a *preference* for barred birds, since with all enemies taken together substantially equal proportions of both kinds of birds were eliminated. In other words, if we assume a selective elimination in the case of predaceous birds, we are obliged to assume an *equal* and *opposite* selective elimination on the part of other unrecorded enemies. There is no evidence on which such an assumption could be based.